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THE PREPARATION OF INSECTICIDAL AEROSOLS BY THE USE OF LIQUEFIED GASES

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Insecticidal aerosols (smokes or fogs) can be prepared by several methods, one of which requires the use of liquefied gas. The insecticide to be dispersed is dissolved in a low-boiling solvent, such as dichlorodifluoromethane or methyl chloride, and discharged into the atmosphere of the infested space. The vapor pressure of the solvent produces the necessary spraying pressure, which does not decrease as long as a drop of liquid is present. As the liquid containing the insecticide is sprayed, a fine mist forms, and the solvent evaporates almost instantly, leaving the insecticide suspended in the air as an aerosol. Such an aerosol is nontoxic to man and animals, noninflammable, and easily applied without the use of heat or power, and yet it is highly toxic to mosquitoes, flies, and many other insects.

Materials

For an aerosol having these desirable properties dichlorodifluoromethane is used as the solvent. This liquid boils at -21.7° F. (-29.8° C.) and has a vapor pressure of 82 pounds per square inch at 68° F. (20° C.). Pyrethrum oleoresin (20 percent total pyrethrins) in amounts sufficient to make about 4 mg. of total pyrethrins per gram of solution is used as the insecticide. It must be filtered to remove small particles that might clog the nozzle. Refined sesame oil is added at the rate of 10 mg. per gram of solution to increase the toxicity.

Apparatus

Cylindrical tanks commonly used to hold 5 pounds of dichlorodifluoromethane can be purchased at almost any local refrigeration supply store. Each tank is equipped with a valve having a 1/8-inch female pipe connection. If the tank is to be used with the valve at the top, a siphon tube must be added, since the solution, not the gas, must be sprayed. For most purposes it is almost as convenient to spray with the tank inverted. The apparatus is shown in figure 1.

The nozzles employed most successfully have been those designed for small oil burners. A Monarch nozzle with an 80° cone, having a capacity of 2 gallons per hour, is suitable for enclosures up to 10,000 cubic feet. With a nozzle of this size 1 or 2 minutes' spraying is sufficient to kill adult mosquitoes in 10,000 cubic feet, with the proper distribution and exposure. Commercially available adapters and screens are used with these nozzles. Other nozzles have been used, one that is designed for spraying vegetables being satisfactory. The space from the valve to the orifice of the nozzle should be small so that not much solution is left in this compartment when the valve is closed after spraying. Any nozzle must have its orifice smaller than the other constrictions to prevent boiling in the nozzle. It can be of iron, brass, or stainless steel.

An oil-burner nozzle, adapter, and screen attached to a small laboratory test apparatus are shown in figure 2.

Preparation of Solution

A clean tank is evacuated with a water pump, a funnel is attached, and the required amounts of pyrethrum oleoresin and sesame oil are introduced. The valve is closed before any air is drawn in. The tank is then connected to a supply tank containing dichlorodifluoromethane which has been turned upside down, and both valves are opened to allow the liquid to flow into the evacuated tank. The supply tank must be warmed or the other tank must be cooled to cause enough liquid to flow. A small amount of a waxy substance in the resin is not soluble in dichlorodifluoromethane, but since it adheres to the inside of the tank it does not interfere.

The amount of dichlorodifluoromethane introduced into the tank containing the insecticide is obtained by difference in weight. The required amount can be determined most easily if a flexible hose connection is used between the two tanks. No tank should be completely filled, lest it burst from the pressure of the expanding liquid should the temperature rise. Shaking causes the insecticide to dissolve, and after the nozzle is attached the package is ready for use.

For experimental work the amount delivered by the nozzle can be determined by loss in weight during spraying for a certain time interval. After this calibration the amount used can be determined by timing.

Other Liquefied Gases

Next to dichlorodifluoromethane methyl chloride is the most convenient solvent. It is, in fact a much better solvent for many

solid insecticides. Methyl chloride is less expensive, its vapor pressure is satisfactory (69.9 pounds per square inch at 68° F.), and it has the advantage of a lower density. Our tests on beans, snapdragons, and carnations indicate that it, as well as dichlorodifluoromethane, can be used where plants are present, since only a small amount is necessary to produce an aerosol. Methyl chloride does have some toxicity to man, about one-fourth that of chloroform, but when insecticides that are toxic to man are to be used, it is not necessary to employ a nontoxic solvent. A large number of insecticides are now being tested in this solvent.

Propane, which is inexpensive, may have a use especially for the dilution of dichlorodifluoromethane, and can be added to a point just below inflammability. It has a vapor pressure of 130 pounds per square inch at 68° F. Dimethyl ether might be used in mixtures with other less inflammable solvents. Carbon dioxide diluted with acetone or alcohol to reduce the high vapor pressure (1,000 pounds per square inch at room temperature) might be employed, but no attempts have been made to use these mixtures.

Other less volatile or nonvolatile solvents have been added to dichlorodifluoromethane. Among those tried are refined kerosene, orthodichlorobenzene, acrylonitrile, acetone, and petroleum ether. At equal parts by volume most of these mixtures show a vapor pressure of more than 50 pounds per square inch, which is still a suitable spraying pressure.

Since a considerable pressure is still retained after dichlorodifluoromethane or methyl chloride has been diluted with slightly volatile or nonvolatile solvents, this method is applicable to the dispersion of some of the less volatile fumigants, such as orthodichlorobenzene, which require a rather high concentration to be effective.

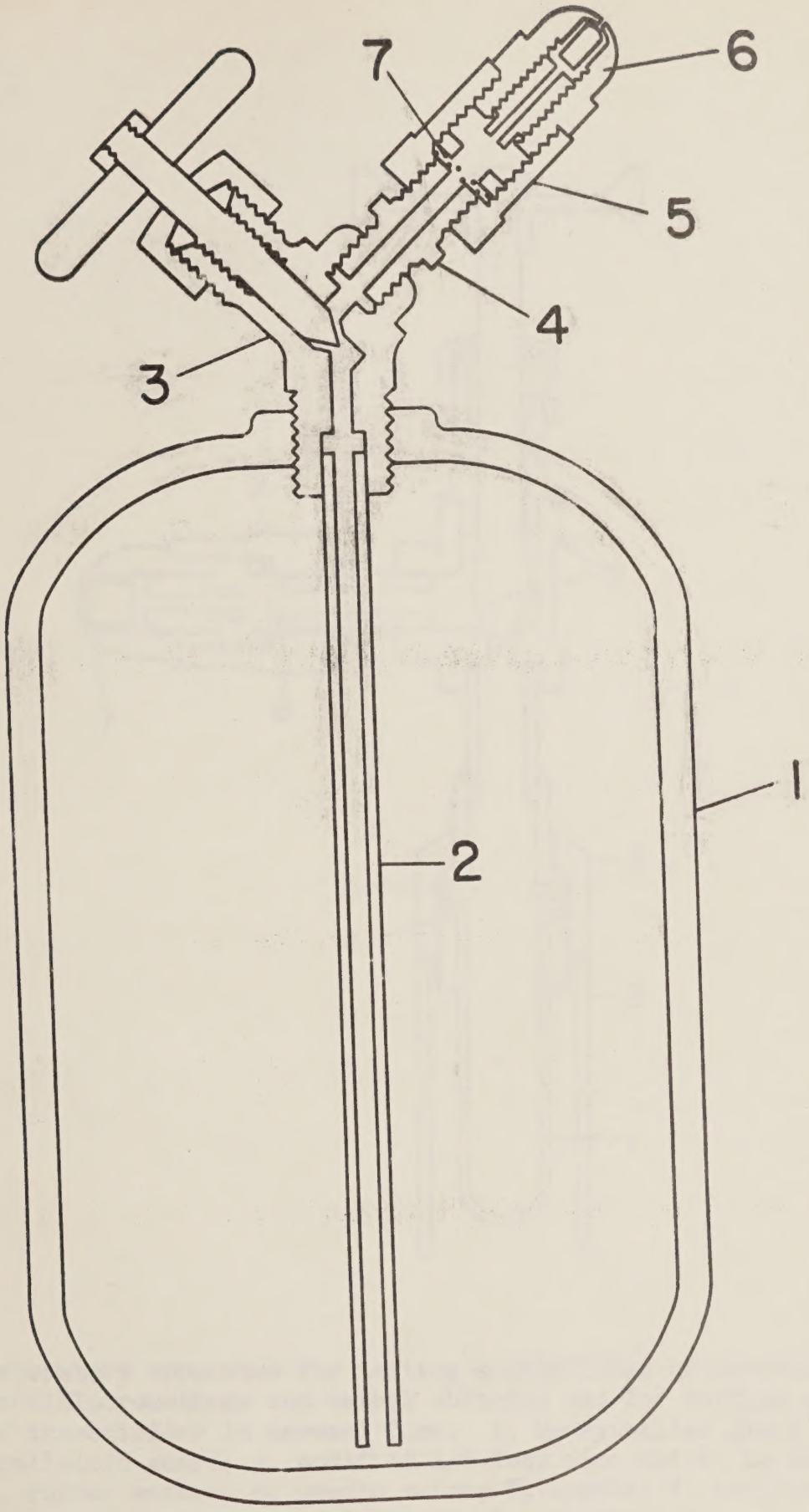
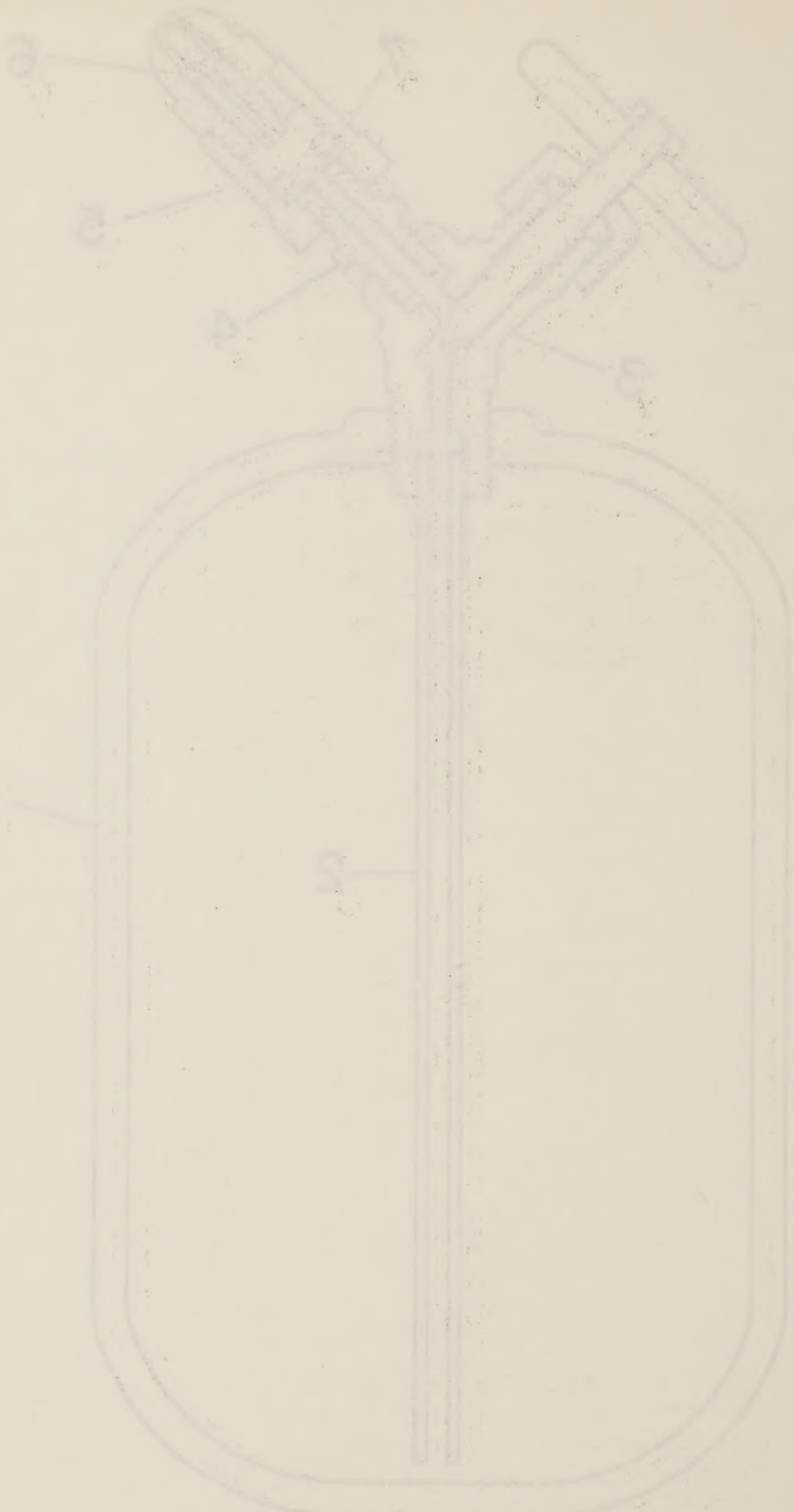


Figure 1.—A diagram showing the apparatus used in the dispersion of insecticidal aerosols: 1, Tank; 2, siphon tube; 3, valve; 4, connection; 5, adapter; 6, nozzle (oil-burner); 7, screen.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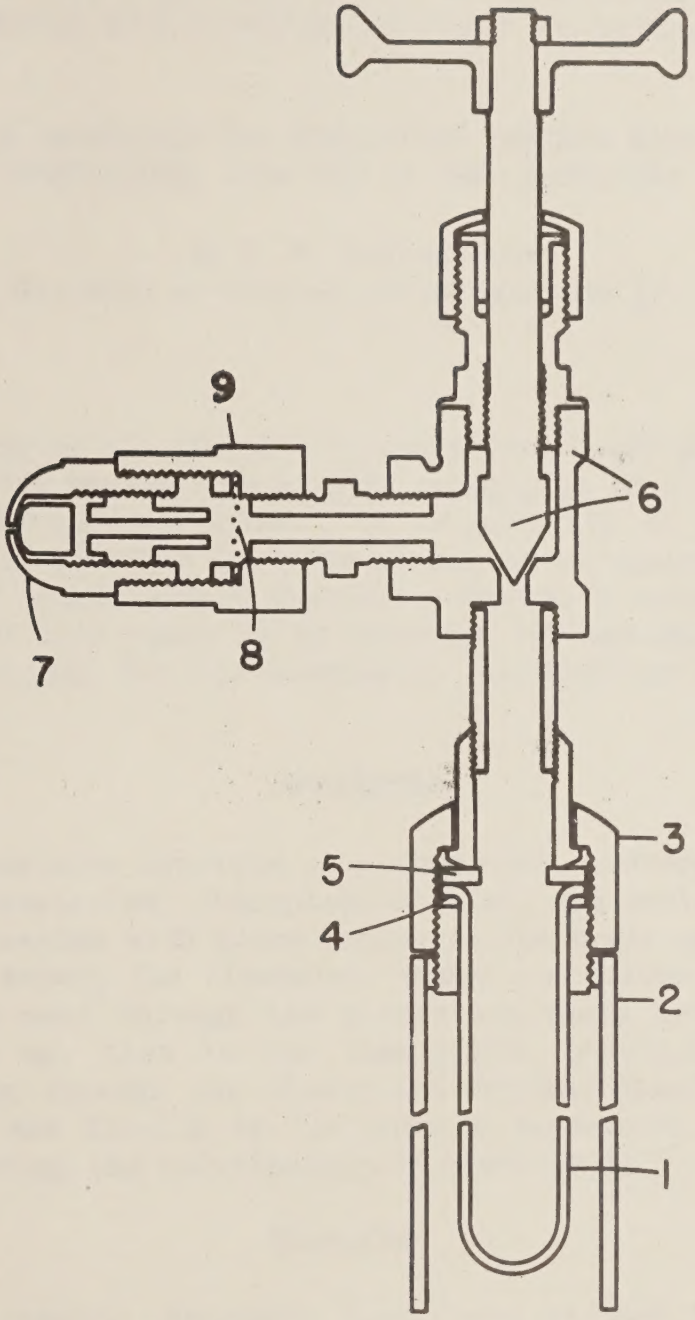

Figure 2.--Laboratory apparatus for testing solubilities of insecticides in dichlorodifluoromethane and methyl chloride and for testing small amounts of insecticides in aerosol form: 1, Heavy-walled glass test tube; 2, celluloid guard; 3, modified 1/8-inch pipe union; 4, leather washer; 5, rubber washer; 6, needle valve; 7, nozzle; 8, screen; 9, adapter for nozzle, screen, and 1/8-inch pipe connection.